

SWOT requirements and SSH measurements from altimetric and in-situ observations

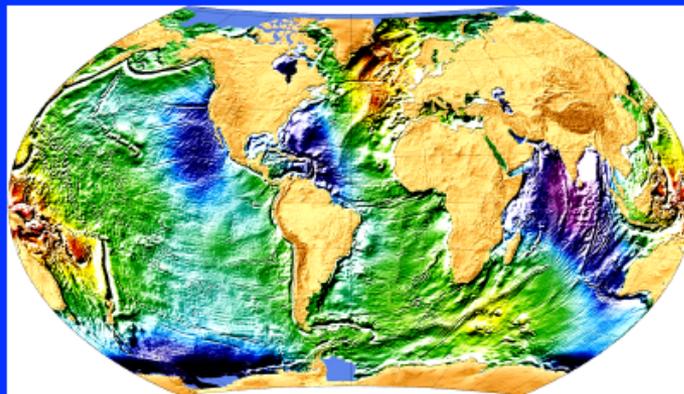
Lee-Lueng Fu and Rosemary Morrow

SWOT Ocean CalVal Workshop

June 16, 2016

Pasadena, CA

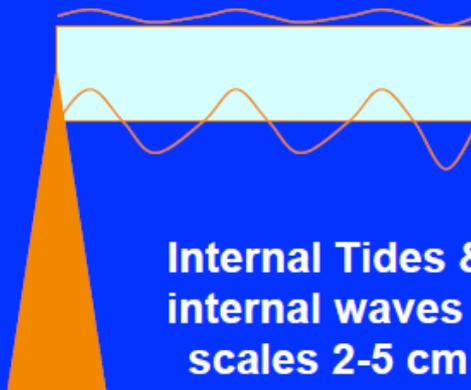
Dynamical Contributions to SSH from 10-100 km



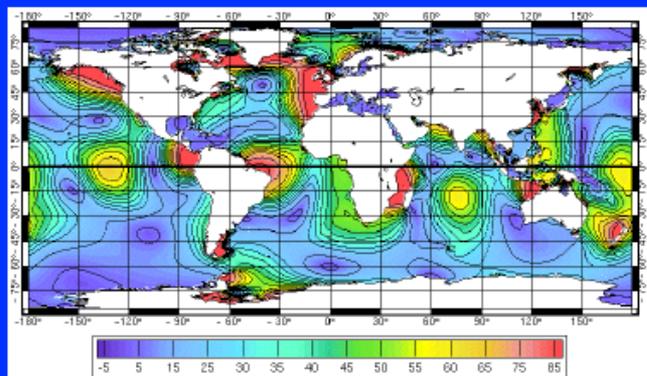
Mean sea surface / geoid
& its errors
SSH of : +/- 100 m

- Large errors at scales < 100 km but invariable in time

Altimetry « Snapshot » at
7 km/s; 840 km in 2 mins



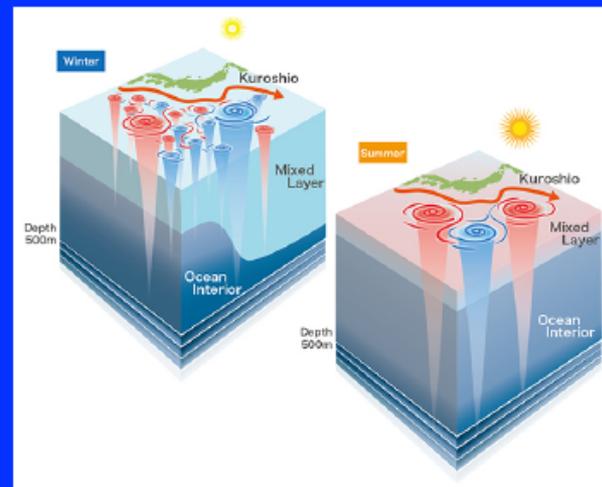
Internal Tides &
internal waves :
scales 2-5 cm



Tides – scales cm – 20 m



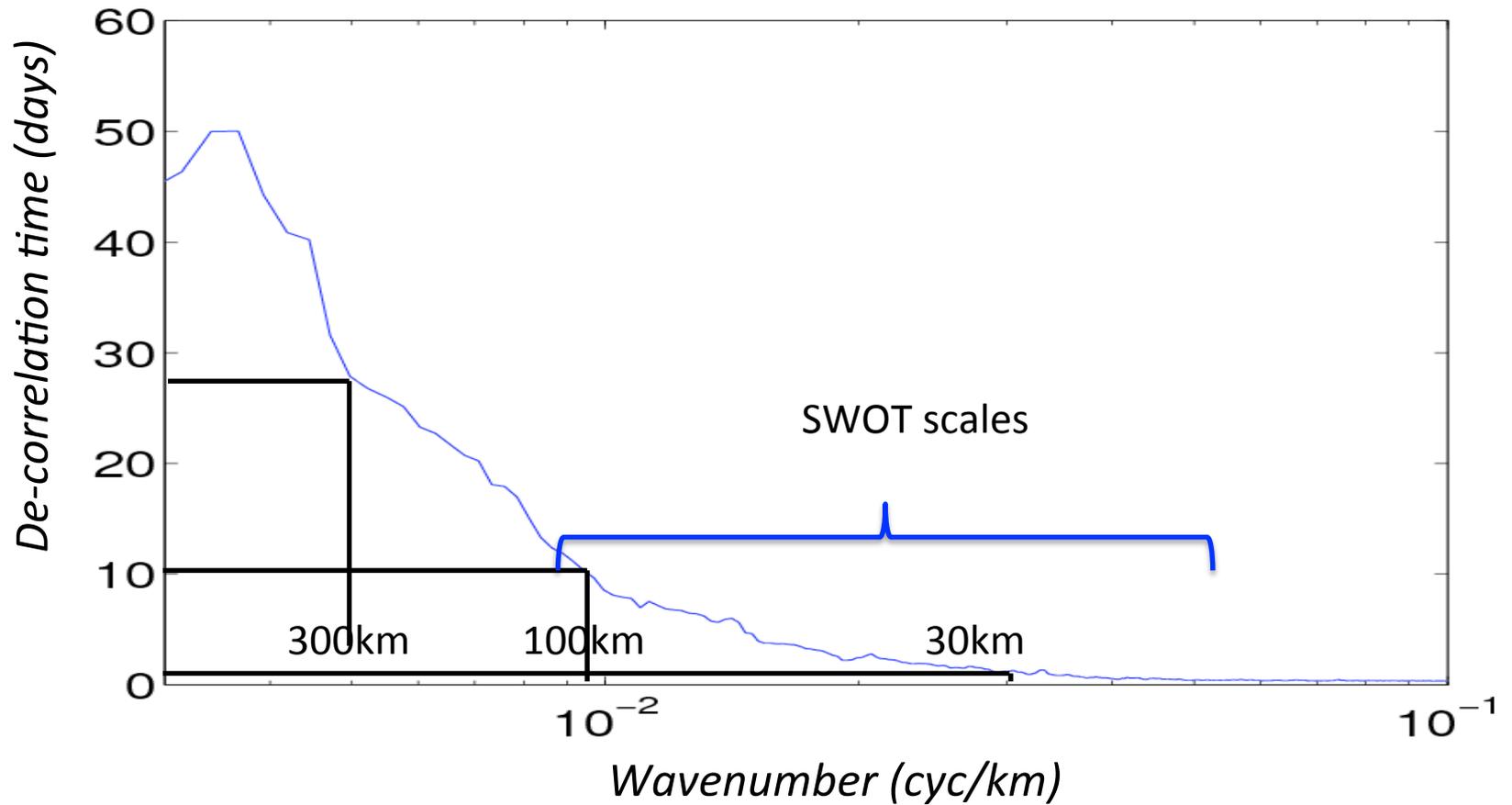
Wind-wave sea state
biases 2-10 cm



Mesoscale & submesoscale
internal dynamics

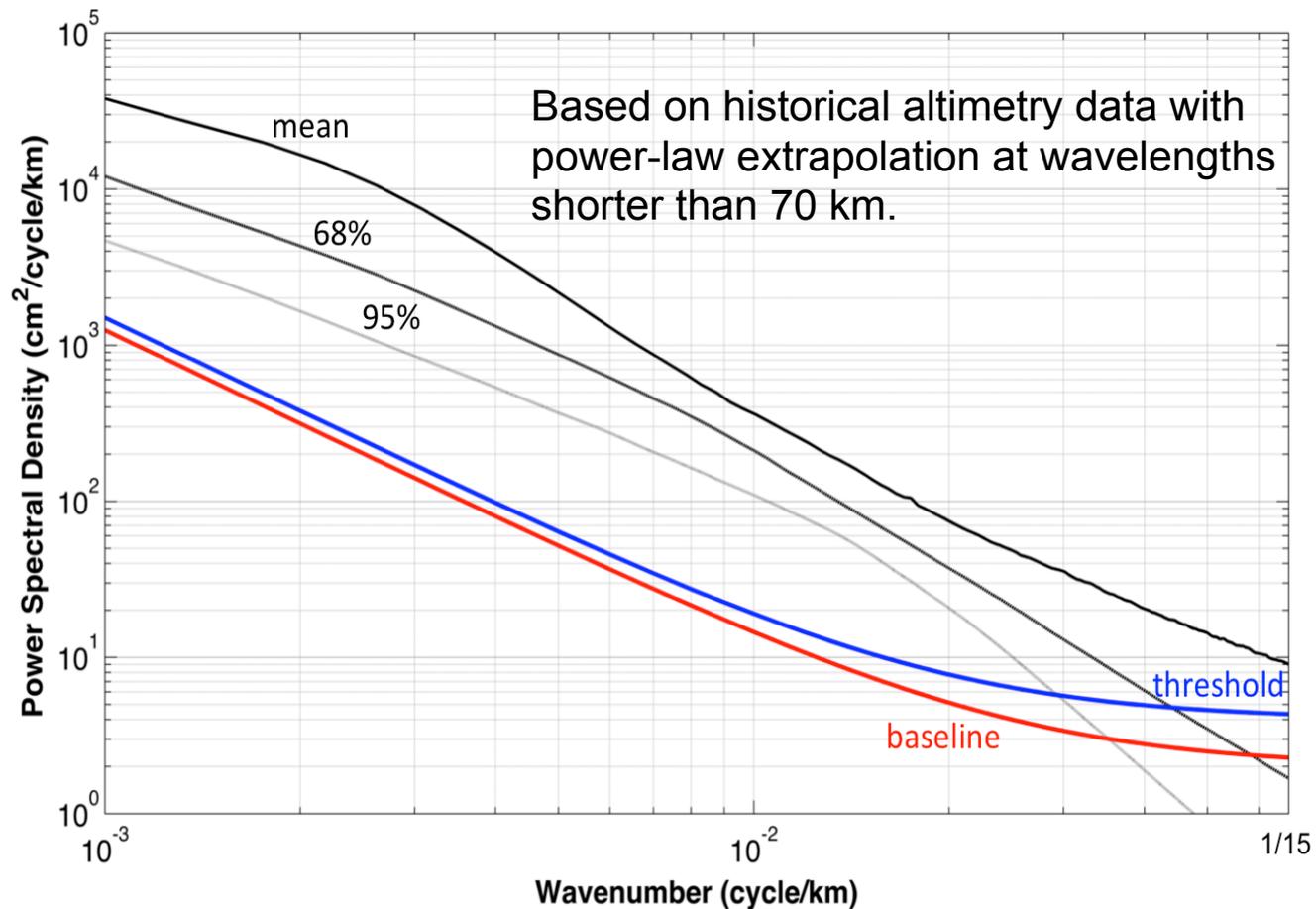
- Scales 2-20 cm

***The time scales of ocean variability decrease
with spatial scales***

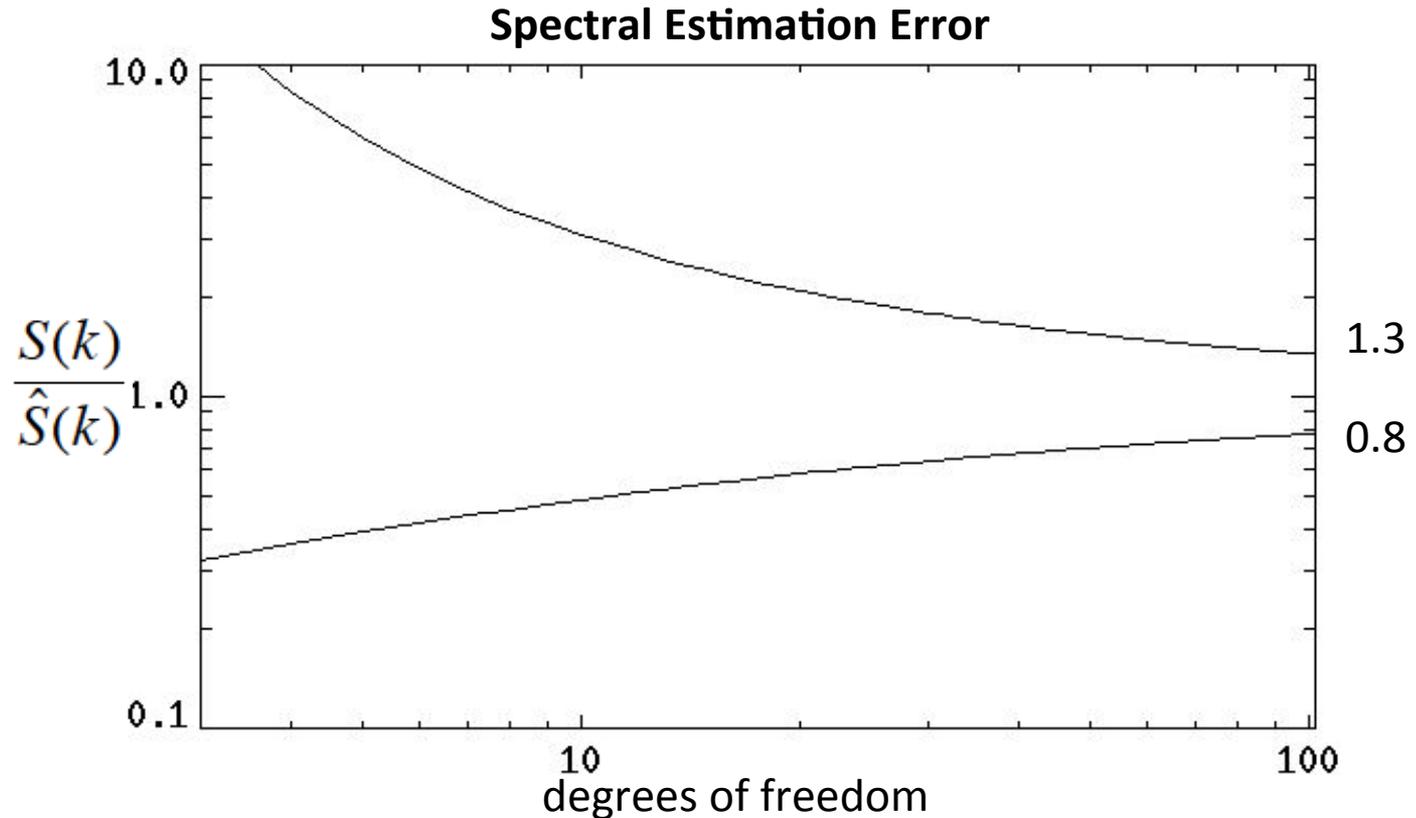


The CalVal requirement for the SWOT SSH measurement

- It is required to validate the wavenumber spectrum of the SSH measurement error via independent observations.
- The independent observations must be synoptic to match the short overflight time of the satellite.



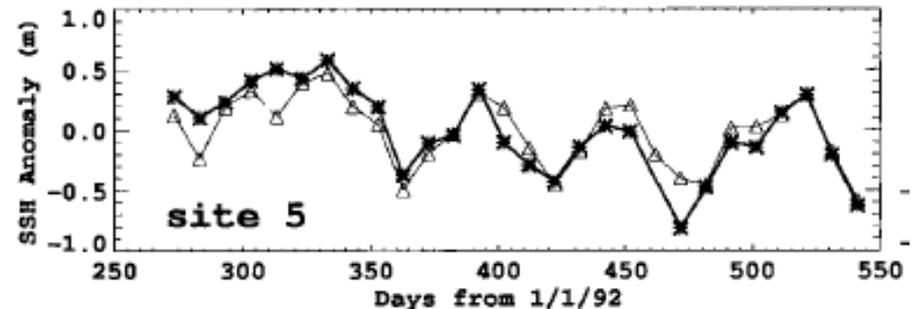
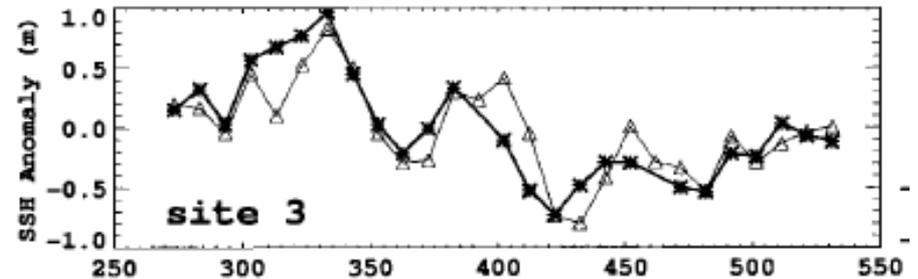
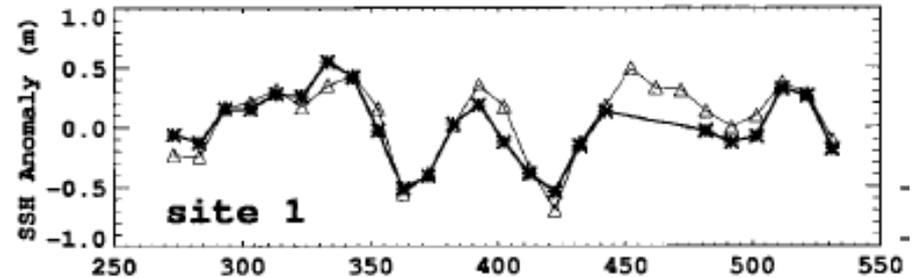
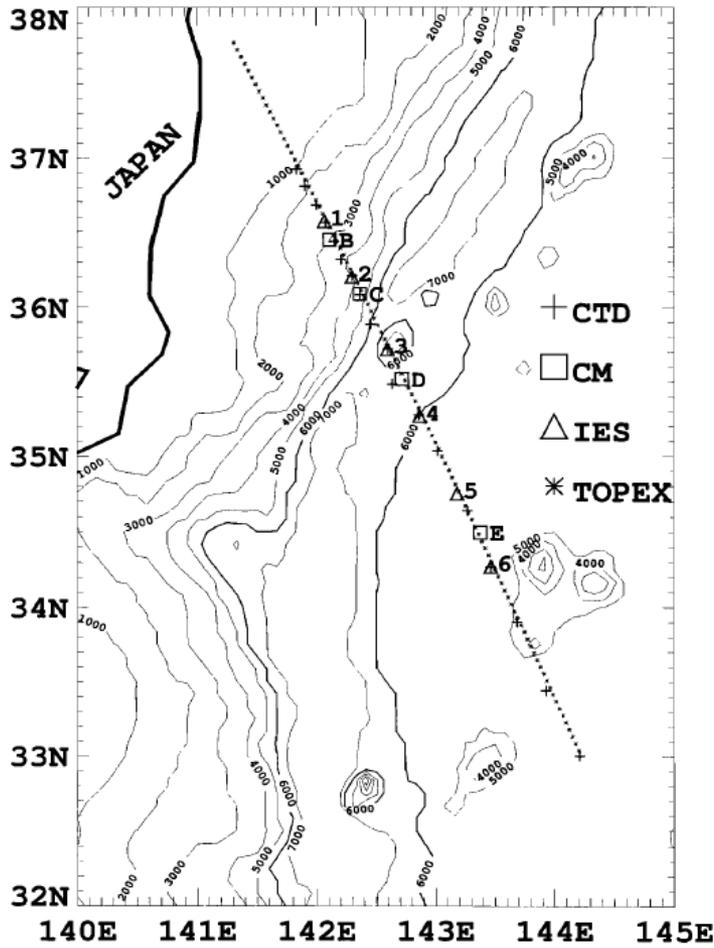
How long is the validation data record required?



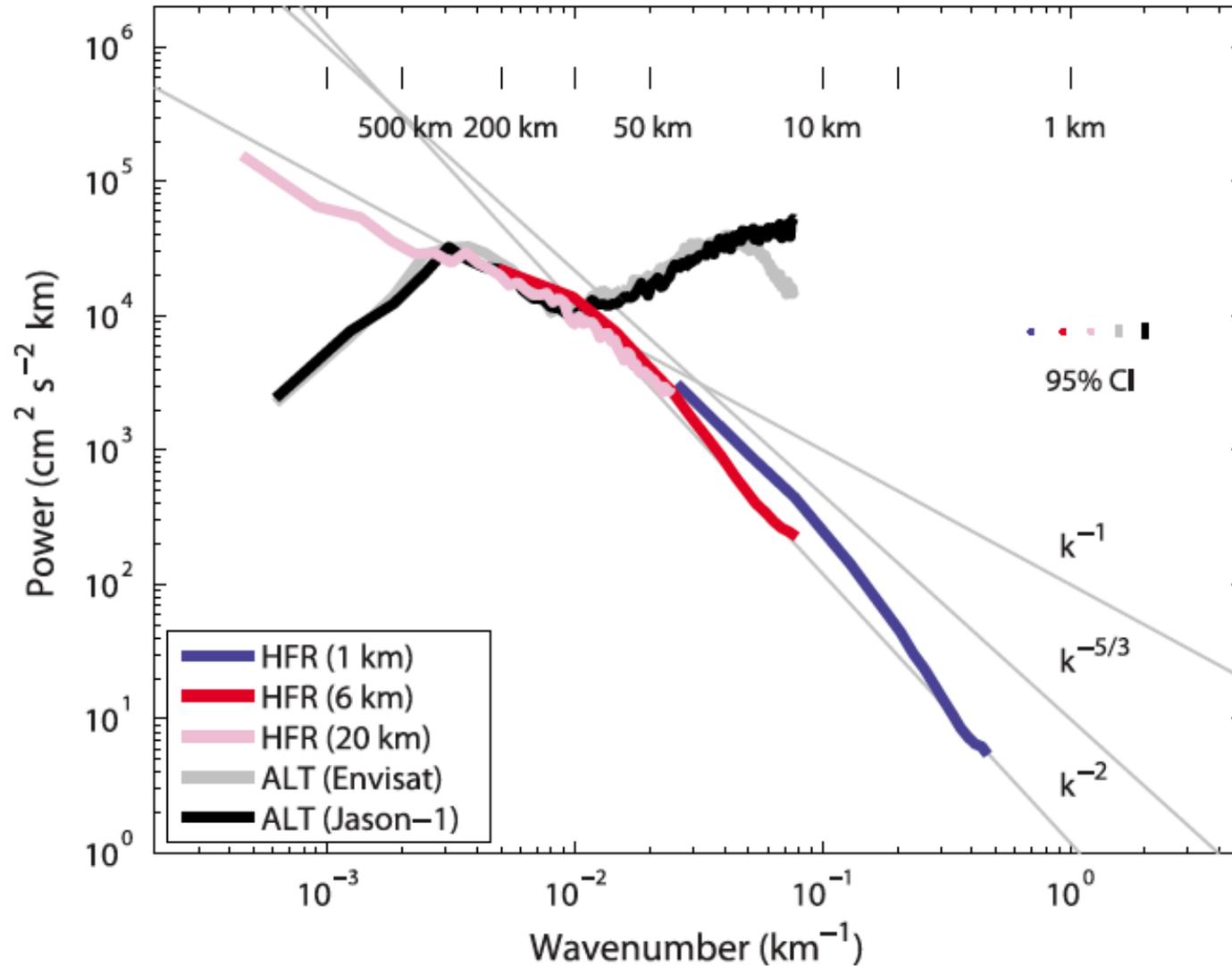
- Need 100 dof to reach error $\sim 30\%$
- Each spectral estimate has 2 dof.
- Need > 50 days of observations.

Along-track Altimetry Calval of the larger mesoscale features

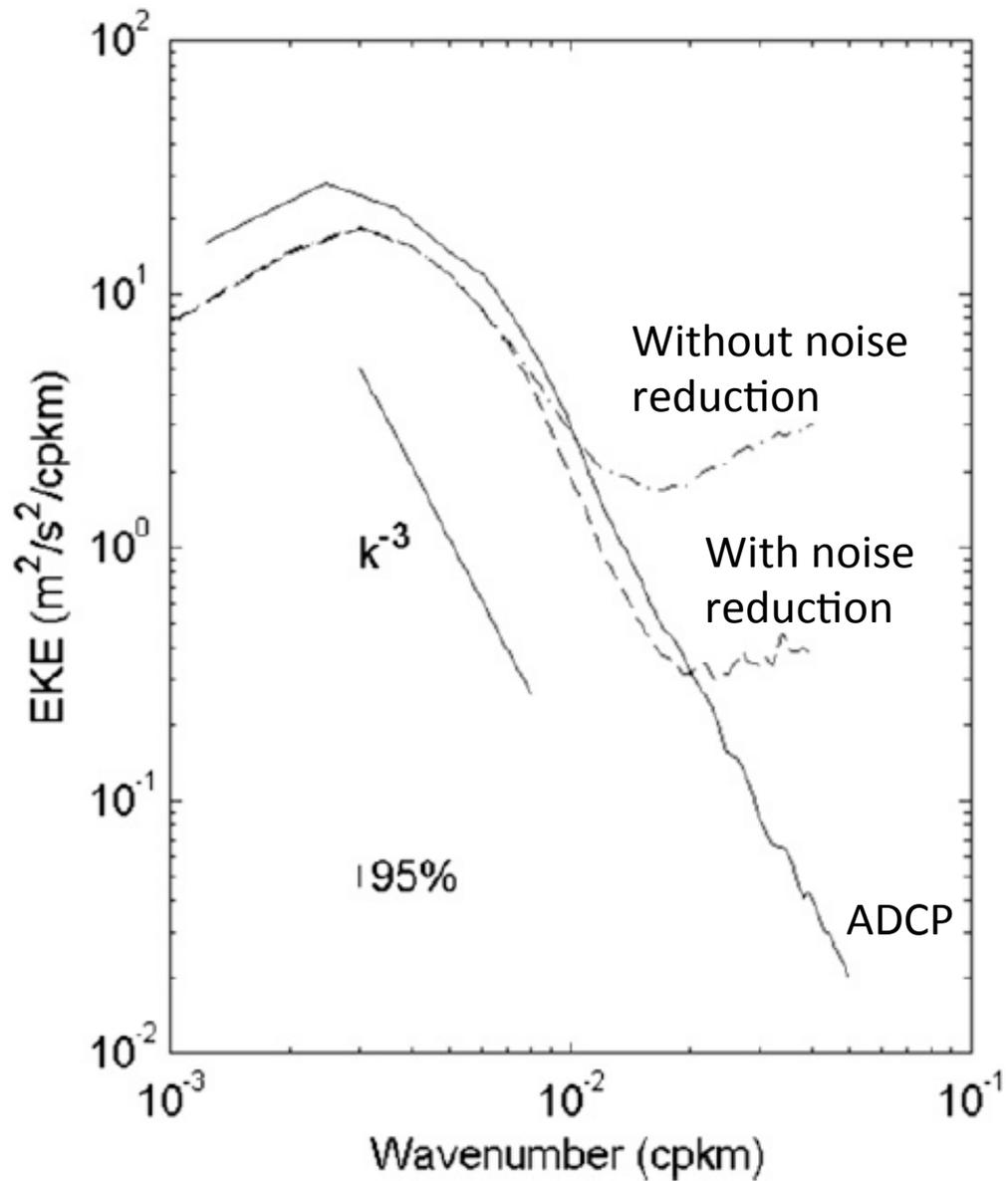
Comparison of TOPEX/Poseidon SSH to IES observations



Comparison of Jason-1/Envisat to High-Frequency Radar



Comparison of Jason to ADCP



Comparison of TOPEX/Poseidon to a basin-wide XBT network

Sea-Land Enterprise Track (PX37/10/44)

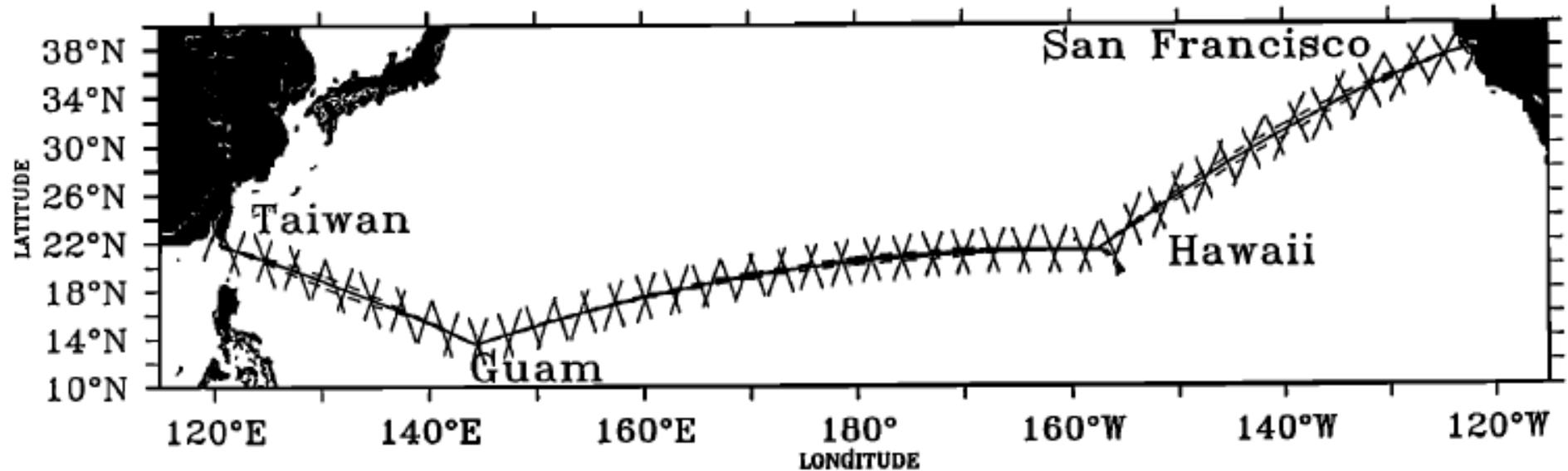
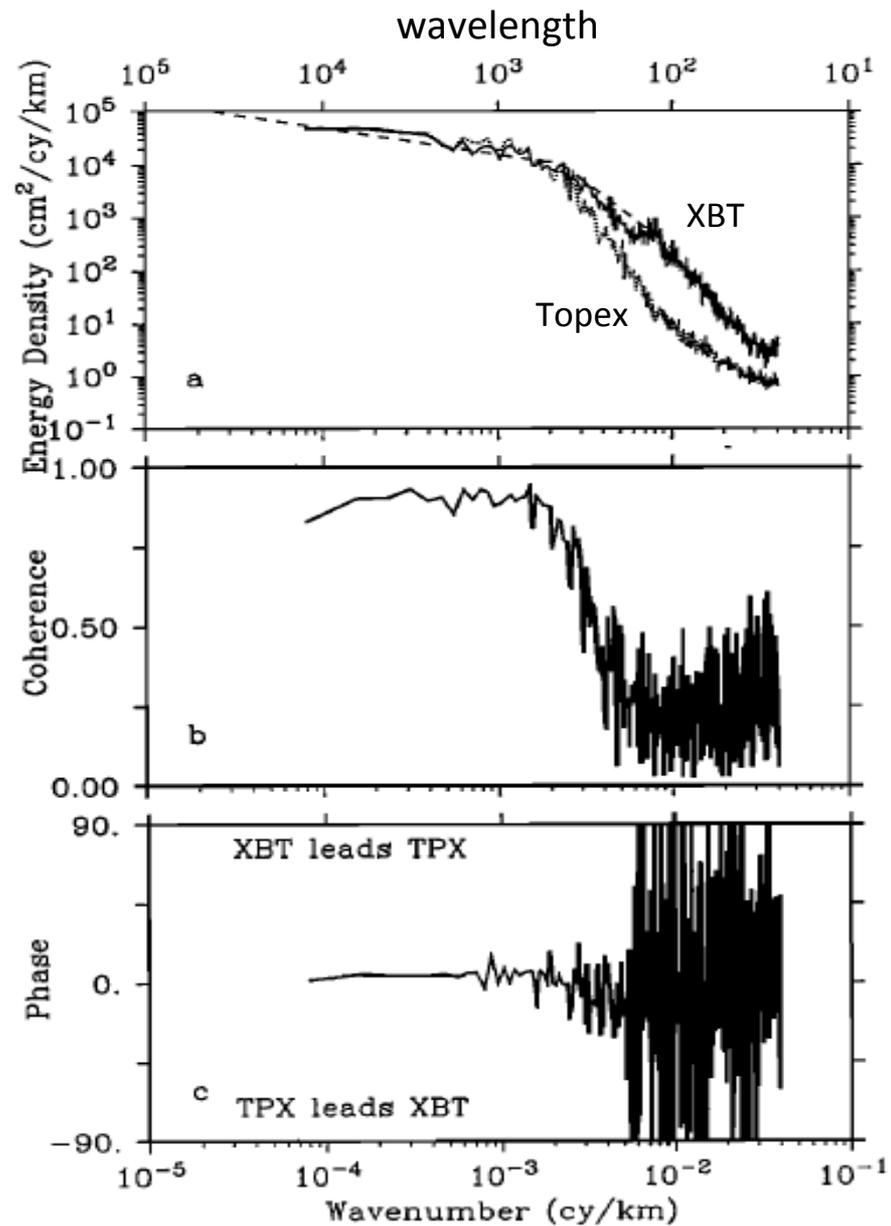


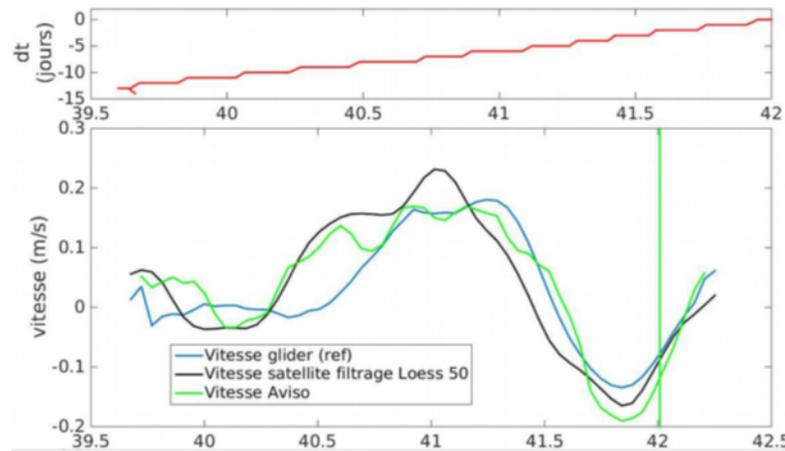
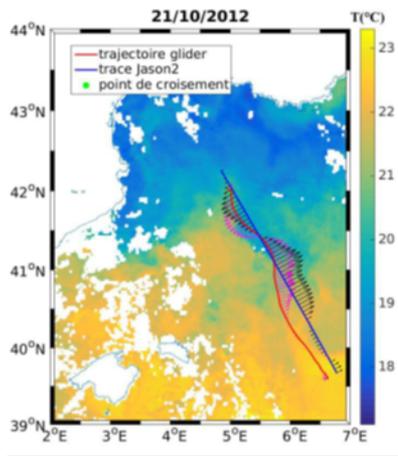
Figure 1. Ship track of SS *Sea-Land Enterprise*, PX37/10/44 (heavy line), from San Francisco to Honolulu to Guam to Taiwan. Long dashed lines indicate the RMS deviation of individual transects from the optimal track. Finer lines are ground tracks of TOPEX/Poseidon altimetric data near the ship track.

Spectrum and Coherence

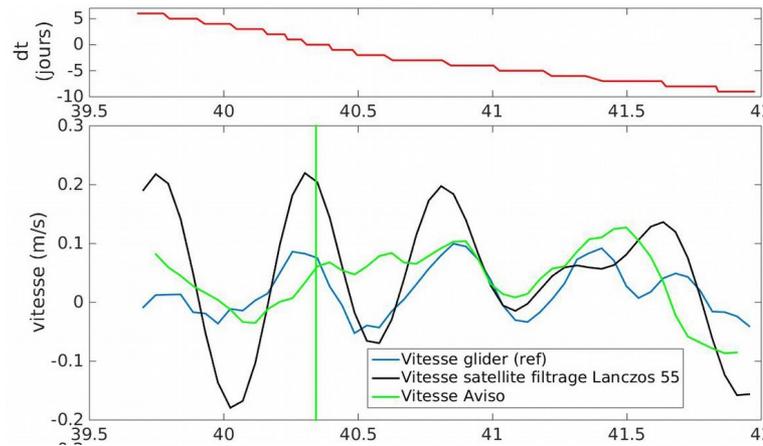
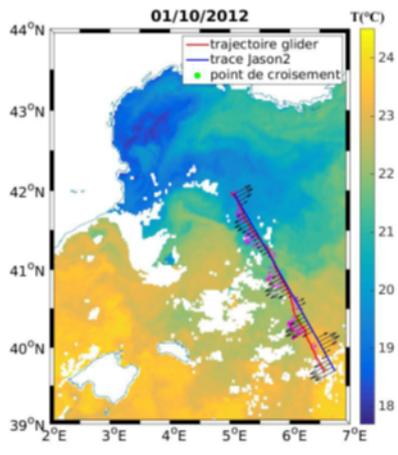


Gliders along altimetry tracks

Altimeter covers a 200 km section in mins, a glider takes 5 days



Large scale features
(100 km diameter
eddy),
=>good match

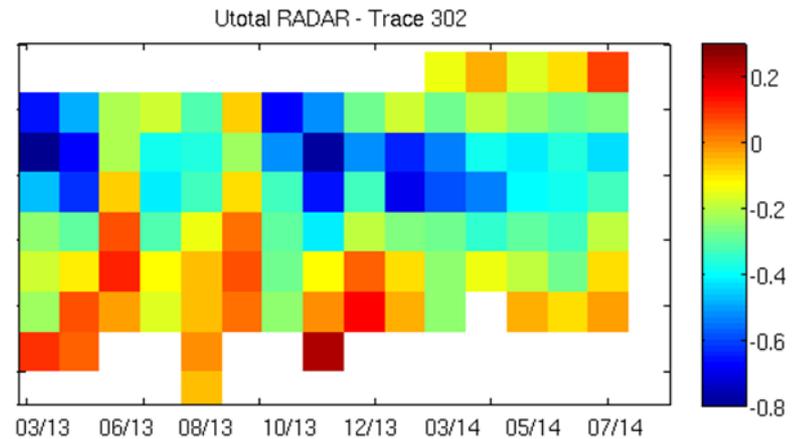
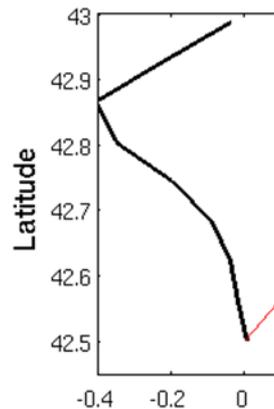
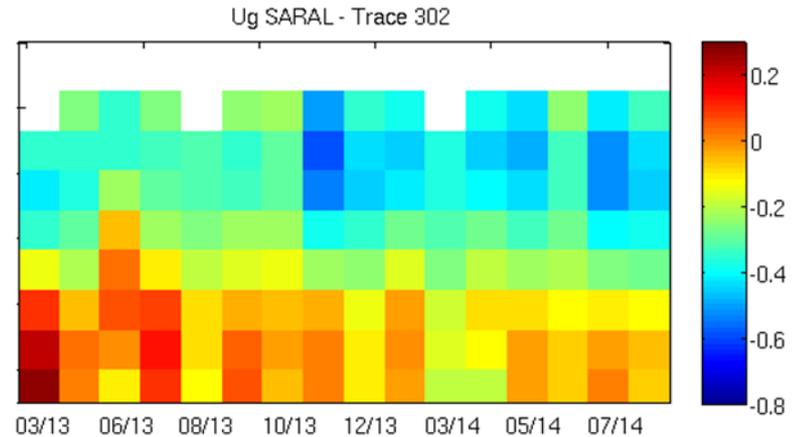
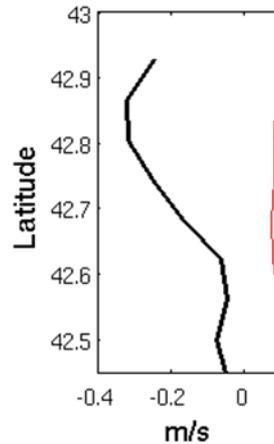
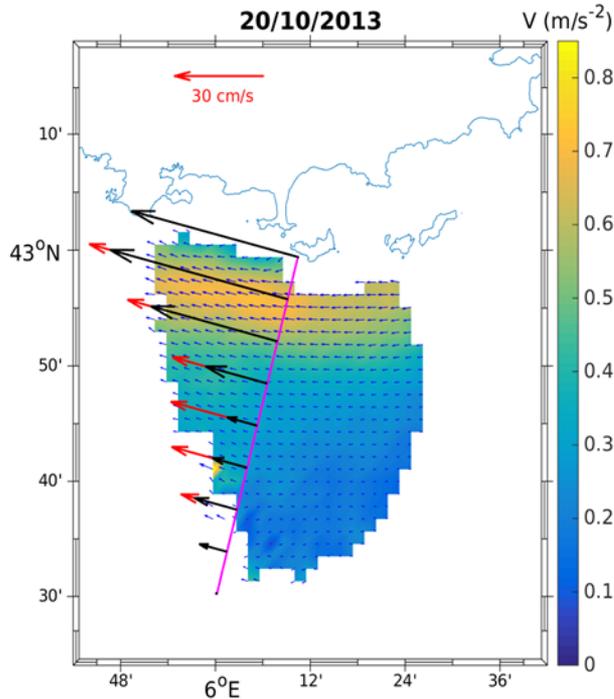


Smaller, rapidly
moving features (40
km diameter),
=>poor match

Altimeter comparison with HFradar

– better temporal resolution, pb of separating geostrophic currents

HF radar at Toulon, measuring Northern Current – width 20 km

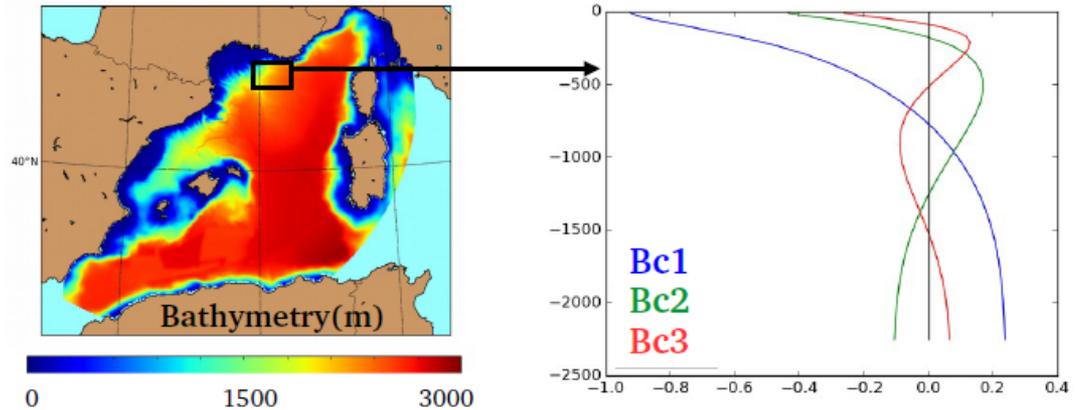


What depth to we need to observe? Impact of BT or BC modes on SSH

2 dominant modes in the Western Mediterranean Sea

Surface pressure:
a proxy of the SSH

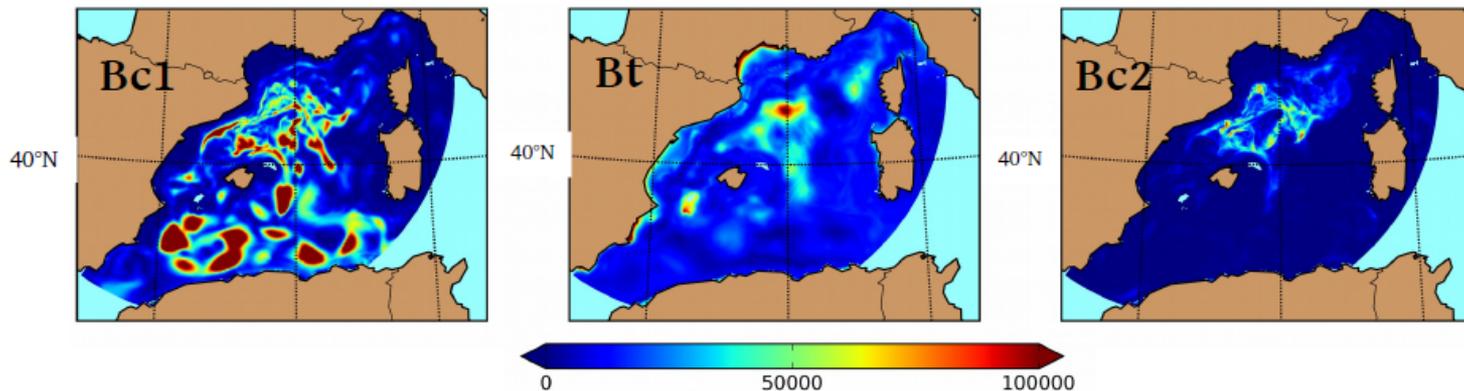
Decomposition on
vertical modes



First baroclinic mode dominant

Importance of the barotropic mode near the coast

Mean variance of the pressure amplitude for barotropic and the two first baroclinic modes over March



Summary

- **In-situ comparison with altimetry observation has a long history based on PIES, XBT, CTD, Gliders, etc.**
- **SWOT will measure rapidly changing features of SSH, posing challenge to making synoptic measurement of SSH for comparison to the snapshot of SWOT.**
- **We will need to establish a quantitative framework for evaluating the relative merits and cost of various in-situ measurements to come up with an optimized observing system for SWOT calval.**

BACK-UP

Comparison of TOPEX/Poseidon to a basin-wide XBT network

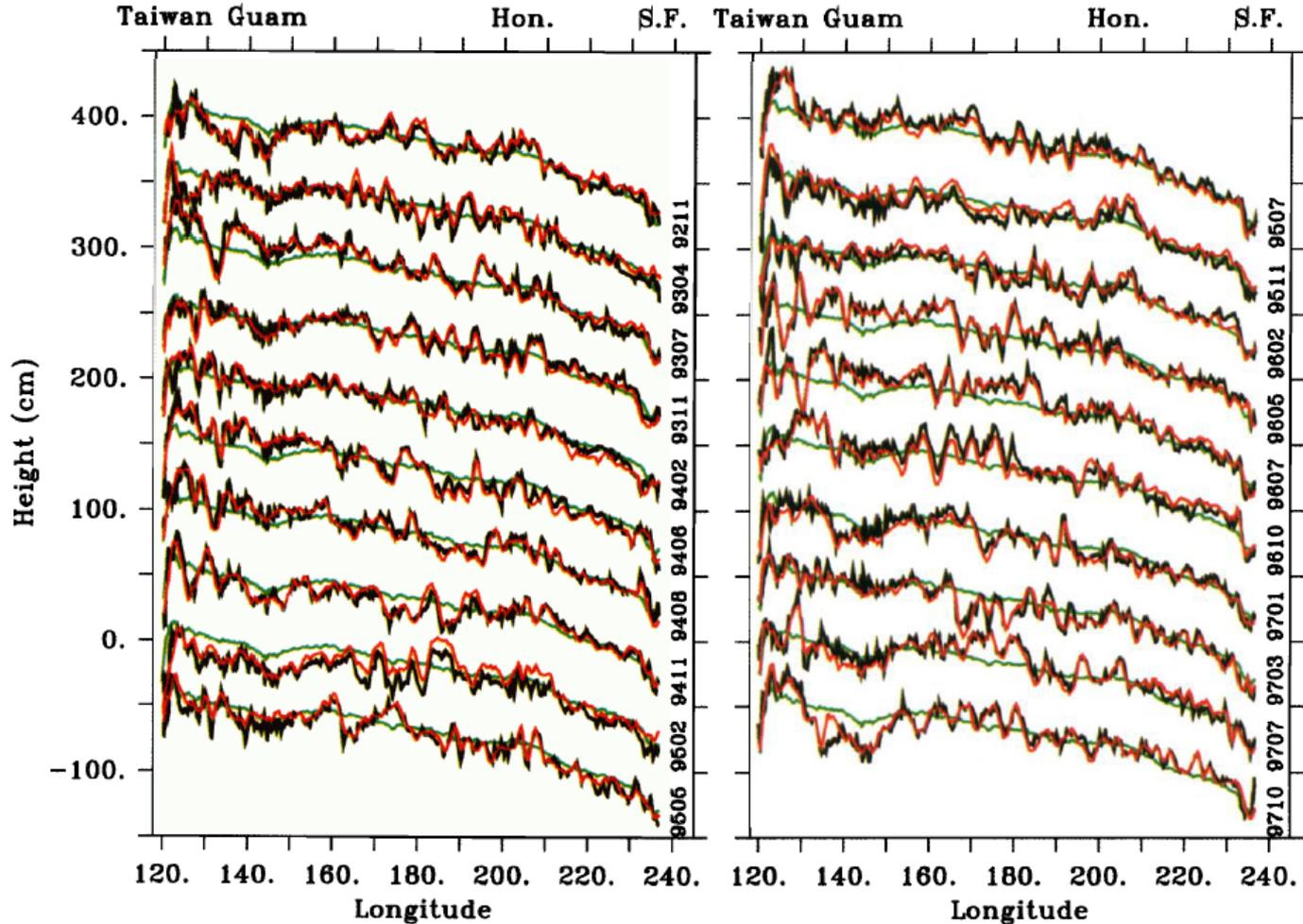


Plate 2. Steric height 0/800 dbars for 20 cruises along the PX37/10/44 track between November 1992 and October 1997 (black lines). The green line, repeated for all 20 cruises, is the temporal mean steric height. Red lines are the T/P altimetric height for the same locations and times, plotted as the anomaly from the mean steric height.

Standard deviation of XBT- altimetry

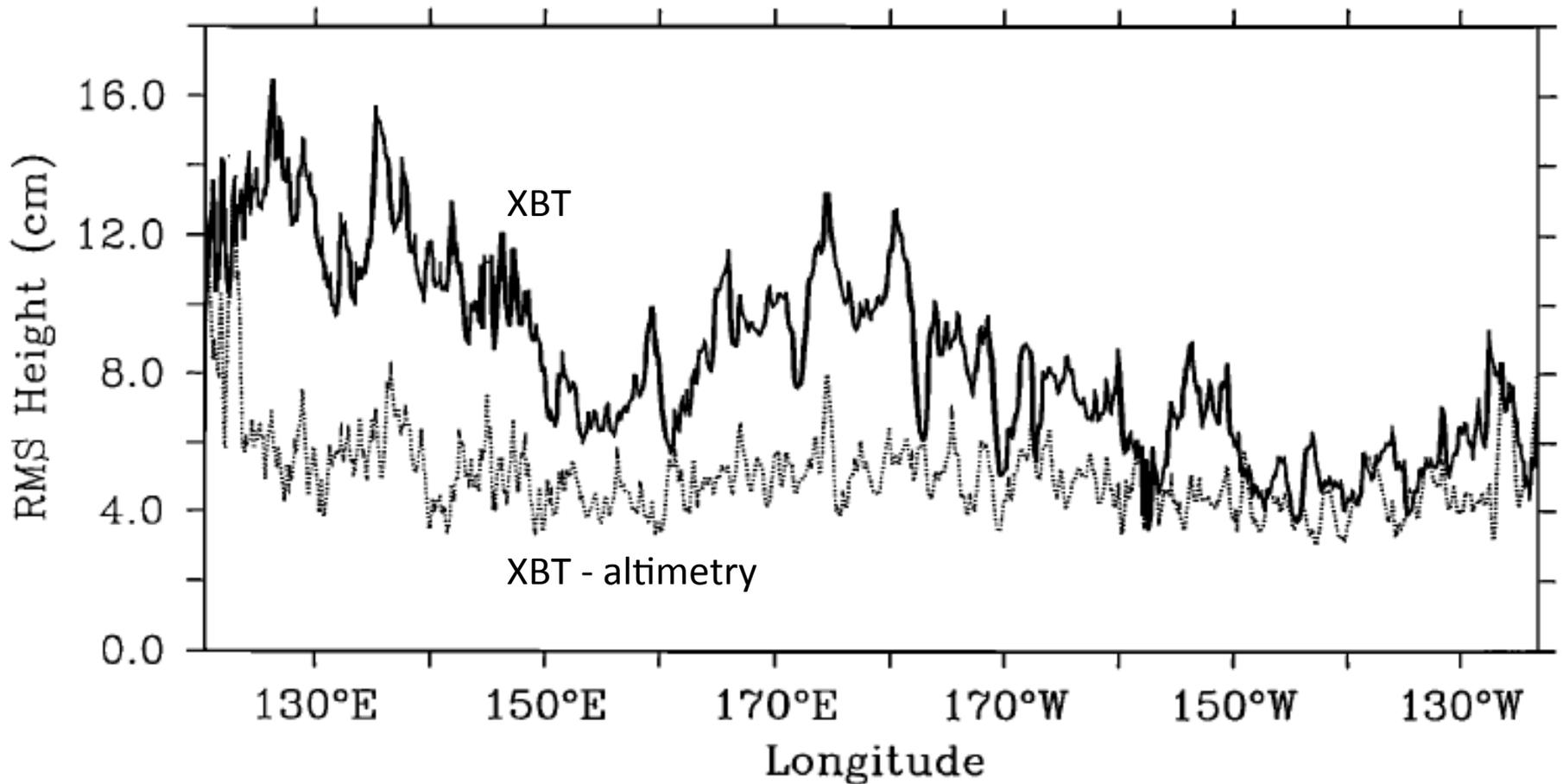


Figure 4. Standard deviation of steric height (0/800 dbars), as a function of longitude, based on the 20 cruises (solid line). The RMS difference (in centimeters) between steric height and altimetric height is also shown (dotted line).